

Advanced Power Electronics and Distributed Energy



EERE Webinar

Yoriko Morita and Matthew Bowers

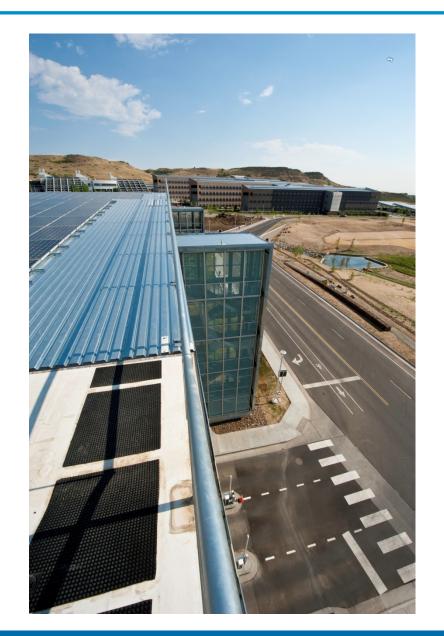
Tuesday September 10th, 2013

Overview

Distributed Energy

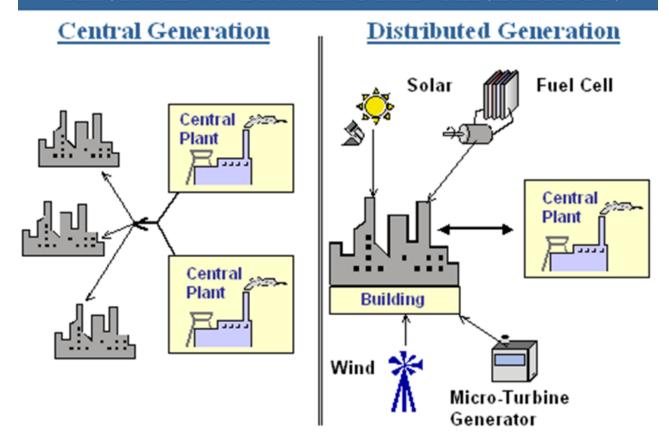
• The 50kW Inverter

ESIF-Energy Systems
Integration Facility



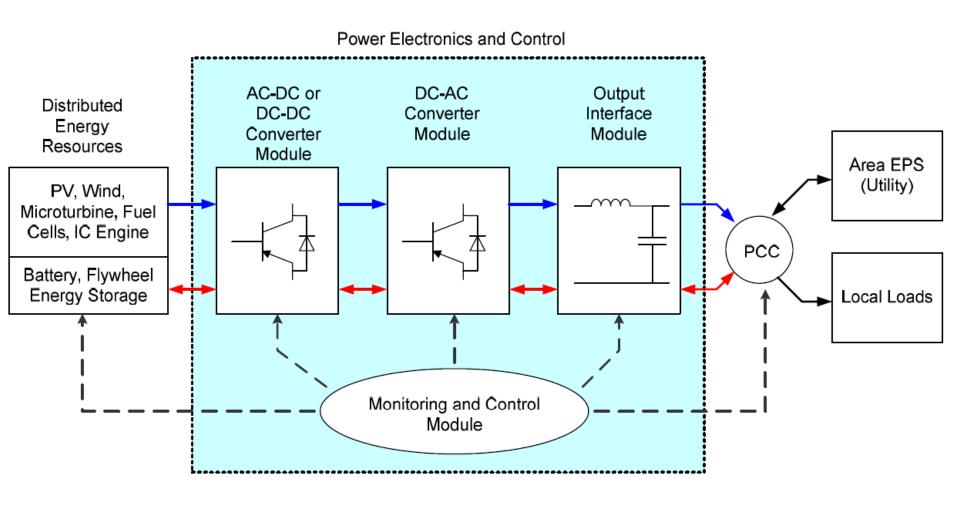
Distributed Generation

CENTRAL vs. DISTRIBUTED GENERATION

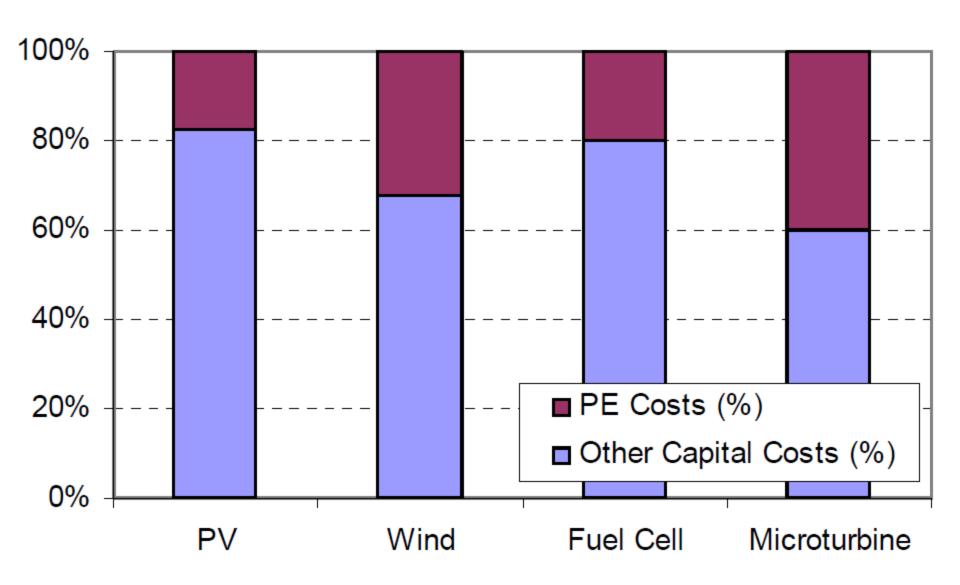


http://energy.gpcog.info/maine-energy-handbook/step-4-identify-efficiency-options/4-2-municipal-sustainable-energy/

Distributed Energy Systems



System Costs



Power Electronics – Current Limitations

- Generally designed for one input/output
 - Specific parameters per project

- Limited flexibility leading to:
 - High maintenance costs
 - High purchase costs
 - Limited applicability



The Partnership









The Solution - 50 kW Power Block

- Scalable
- Modular

- Semikron PM1000 IGBT
- National Instrument's sbRIO platform
 - Xilinx Spartan FPGA

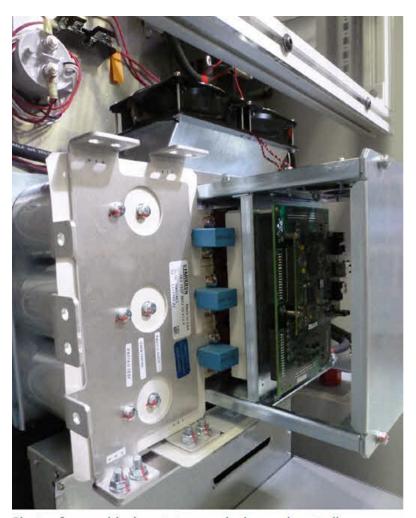


Photo of power block prototype and advanced controller. Photo by Joshua Bauer, NREL

Inverter Layout

Air Out (Fans)

Cable Terminals

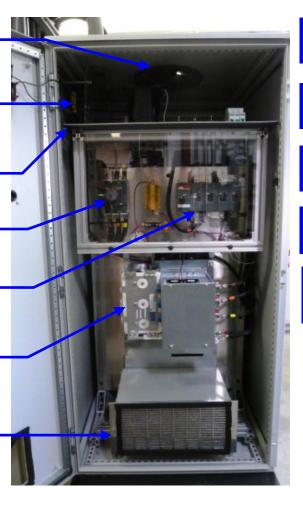
Accessories Rack

AC CB

DC Disconnect

50kW Power Block

Air Intake (Blower)



Aux. DC Supplies

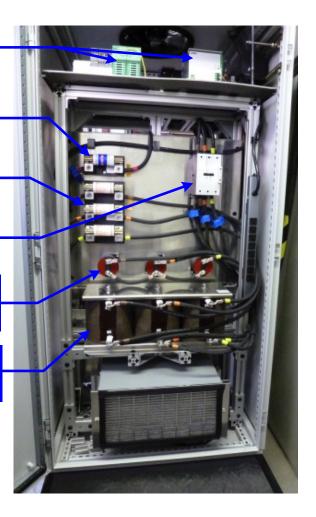
DC Fuse

AC Fuses

AC Contactor

AC Filter Capacitors

AC Filter Inductors



NREL Software Development

- LabVIEW FPGA
- IEEE 1547 compliant
 - Island Protection
- Maximum Power Point Tracking
- Feedback Control Loops
- Pulse-Width Modulation

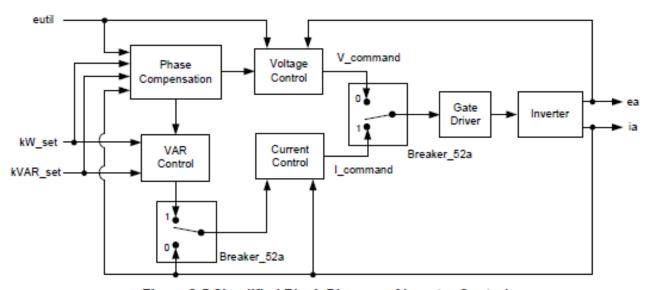
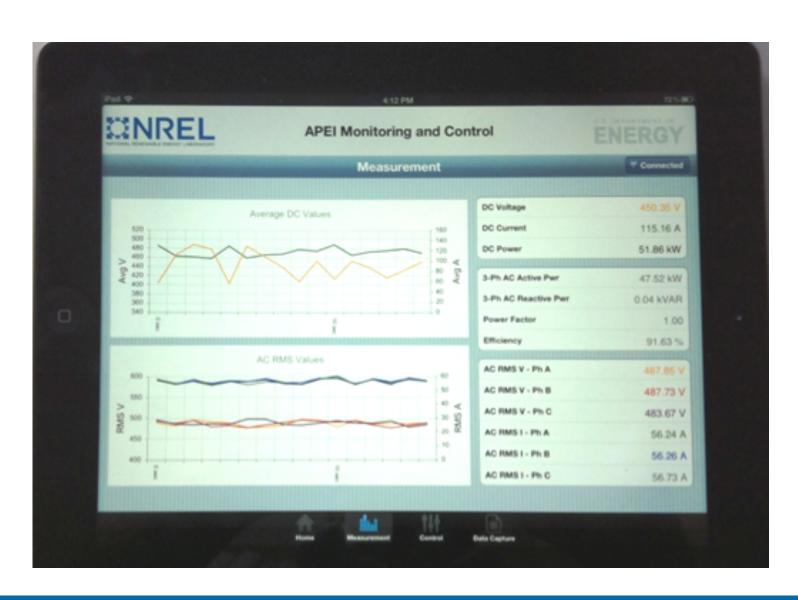
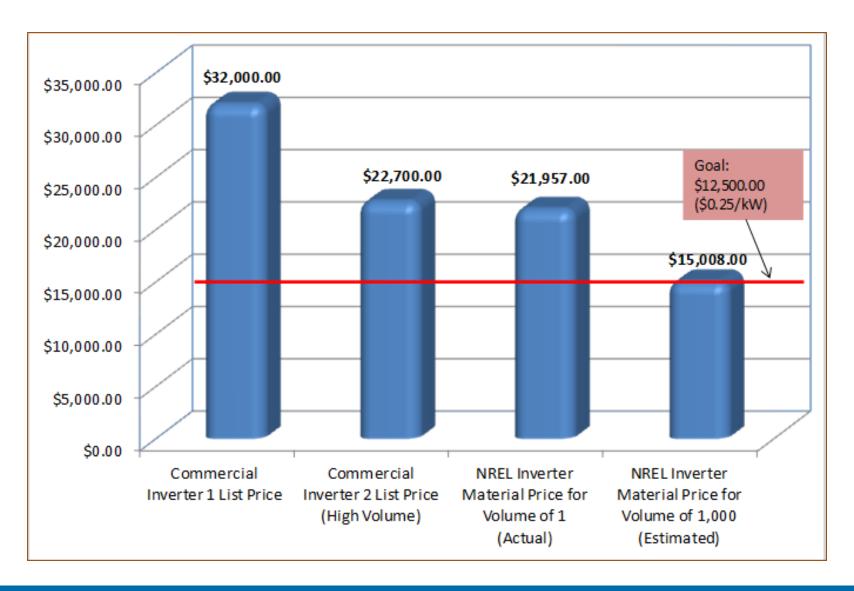


Figure 2-5 Simplified Block Diagram of Inverter Control

Monitor and Control Interface



Costs



ESIF-Energy Systems Integration Facility



ESIF Testing Ability

Hardware-in-the-Loop connections at Megawatt-Scale Power:

- o Conduct integration tests at full power and actual load levels in real-time simulations
- Evaluate component and system performance before going to market.

High Performance Computing Data Center:

- Peta-scale computing
- Large-scale modeling and simulation of material properties, processes, and fully integrated systems

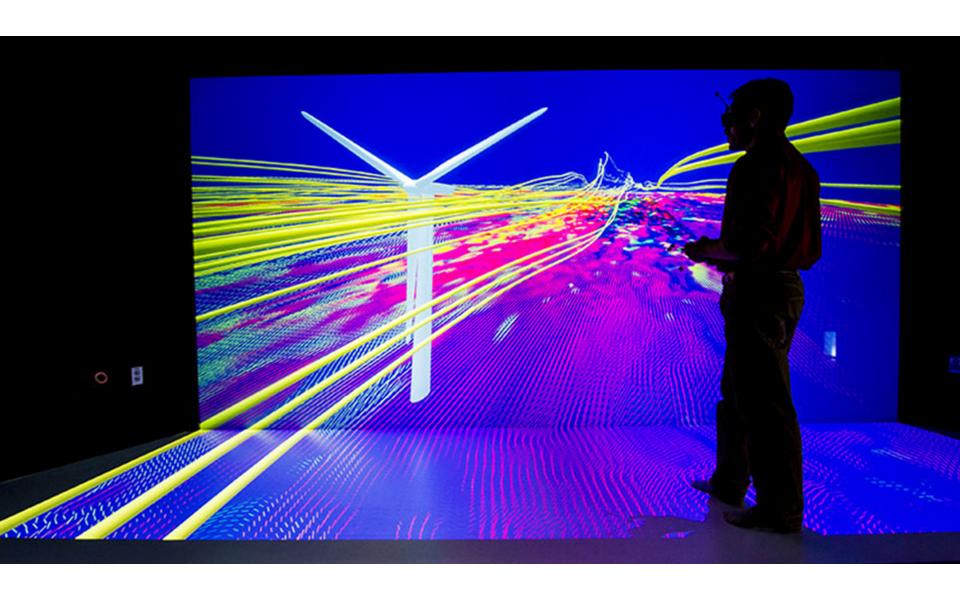
Uniquely Connected:

- The Research Electrical Distribution Bus
- Two AC and two DC ring buses that connect multiple sources of energy and interconnect "plug-and-play" testing components in all the labs.

Data Analysis and Visualization:

 Fully integrated with hardware-in-the-loop at power capabilities, an electrical distribution bus, a SCADA system, and Petascale computing... testing and visualization in a completely virtual environment.

Conclusion



NREL Contacts

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Energy Innovation Portal Listing

http://techportal.eere.energy.gov/technology.do/techID=1101

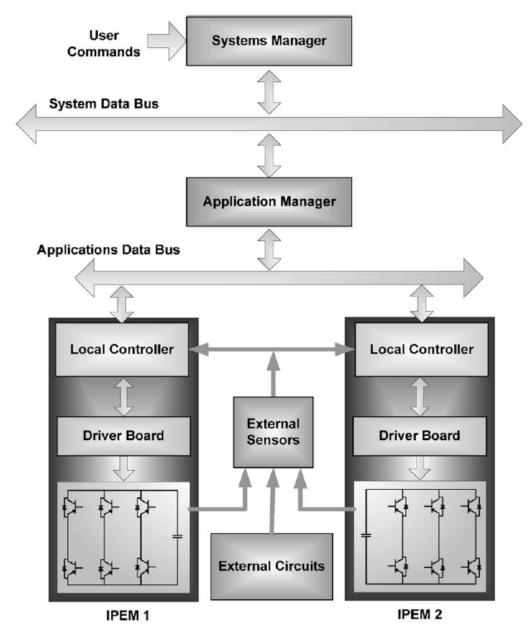


Fig. 15. Hierarchical division of control functionalities for IPEMs.